

**Fishery Data Series No. 93-4**

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# **Comparative Catch Per Unit of Effort of Resident and Stocked Species of Fish Test Netted in Harding Lake, 1992**

**by**

**Cal Skaugstad**

March 1993

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Alaska Department of Fish and Game

Division of Sport Fish



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OF RESIDENT AND STOCKED SPECIES  
OF FISH TEST NETTED IN  
HARDING LAKE, ALASKA, 1992<sup>1</sup>

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## ABSTRACT

To evaluate enhancement efforts in Harding Lake, resident and stocked fish populations were sampled with: fyke traps in the littoral zone, sinking gill nets in the benthic zone, and vertical gill nets in the pelagic zone in August and September 1992. Catches of stocked species were: 117 Arctic char *Salvelinus alpinus*, eight kokanee *Oncorhynchus nerka*, zero Arctic grayling *Thymallus arcticus*, and zero rainbow trout *Oncorhynchus mykiss*. Catches of resident species of fish were: 57 northern pike *Esox lucius*, 25 burbot *Lota lota*, 23 lake trout *Salvelinus namaycush*, and 303 least cisco *Coregonus sardinella*. In the three depth zones, 32 fish were captured in the littoral zone, 346 fish were captured in the benthic zone, and 155 fish were captured in the pelagic zone.

KEY WORDS: Harding Lake, stocking evaluation, Arctic char, *Salvelinus alpinus*, rainbow trout, *Oncorhynchus mykiss*, Arctic grayling, *Thymallus arcticus*, northern pike, *Esox lucius*, burbot, *Lota lota*, least cisco, *Coregonus sardinella*, lake trout, *Salvelinus namaycush*, kokanee, *Oncorhynchus nerka*, catch per unit effort, growth.



## INTRODUCTION

Harding Lake is about 92 km from Fairbanks along the Richardson Highway. Surface area of the lake is about 1,000 ha and maximum depth is 43 m. Resident species include northern pike *Esox lucius*, burbot *Lota lota*, and least cisco *Coregonus sardinella*. Lake trout *Salvelinus namaycush* were stocked in the 1930's and 1960's and have developed into a small reproducing population. While Harding Lake is used extensively for outdoor recreation, it supports a much smaller sport fishery in terms of angler-days than do other large, stocked, roadside lakes close to population centers in the Tanana Valley. It has long been the perception of fisheries managers that Harding Lake could support a much larger sport fishery than it currently does or has in the past. Increasing sport fishing effort at Harding Lake has been a goal of the Alaska Department of Fish and Game (ADF&G) for several years. In keeping with this goal, enhancement efforts aimed at improving sport fishing in Harding Lake have occurred for many years (Doxey 1991; Clark et al. 1991; Viavant 1992b).

Prior to 1990 enhancement efforts involved stocking kokanee *Oncorhynchus nerka* and Arctic grayling *Thymallus arcticus* sac fry (15-20 mm), and Arctic grayling and rainbow trout *Oncorhynchus mykiss* fingerlings (50-80 mm) directly into the lake. Arctic grayling and rainbow trout used in these stockings were surplus production from hatcheries. Survival of these fish probably was very low because no significant fisheries developed as indicated by the statewide harvest survey (Mills 1987-1992) and few fish have been captured in gill nets and with sport gear (Doxey 1989, 1991). However, recent stockings of catchable ( $\geq 200$  mm fork-length FL) Arctic char *Salvelinus alpinus* developed into fisheries (Viavant and Clark 1991a and 1991b; Table 1). Stockings of smaller Arctic char ( $> 150$  mm) during the same period comprised only a small portion of the catch in these fisheries (Viavant 1992a). Because the probability of establishing a fishery appeared to be related to the size of the fish at the time of stocking, larger Arctic grayling and rainbow trout were requested from the hatcheries. However, the hatcheries could not provide the desired number of large fish. In 1990 and 1991 experiments were conducted to evaluate methods for rearing game fish in floating net-pens at Harding Lake. Rearing game fish in net-pens in Harding Lake proved to be a cost effective method of providing catchable ( $\geq 200$  mm) fish for stocking into Harding Lake (Clark et al. 1991; Viavant 1992b).

Some assessment of the success of these stocking efforts began in 1986 using gill nets, fyke traps, and angling. Assessments were made by comparing the catch rates of fish species in Harding Lake; population estimates have not been attempted. These comparisons indicated that Arctic char were the most successful species stocked into Harding Lake and also had resulted in some catch and release angling (about two caught and released for every one harvested; Table 1). Although few large ( $\geq 200$  mm) rainbow trout and Arctic grayling were captured in nets or by angling during these studies, the statewide harvest survey (Mills 1987-1992) indicated that small fisheries have developed for these species.

The objective for 1992 was to estimate the median catch per unit of effort (CPUE) for Arctic char and rainbow trout by zone during late August. In

Table 1. Fishing effort and harvests of wild and stocked fish, Harding Lake, 1986-1991.

	Year <sup>a</sup>					
	1986	1987	1988	1989	1990 <sup>b</sup>	1991 <sup>b</sup>
Number of Days Fished	2,064	5,125	3,256	4,935	3,895	5,155
Number of Anglers	1,590	3,371	2,599	2,976	2,650	3,241
Number of Fish Harvested (Caught):						
Arctic char	0	0	0	141	304 (996)	450 (2,076)
Arctic grayling	0	79	0	0	17 (84)	86 (147)
Burbot	0	53	73	10	17 (17)	45 (45)
Lake trout	24	0	55	119	51 (186)	133 (148)
Northern pike	673	1,886	2,092	1,764	591 (3,629)	1,888 (4,595)
Rainbow trout	0	118	73	456	354 (1,182)	246 (277)
Sheefish	0	0	73	0	0 (68)	0 (0)
Kokanee	0	0	0	0	0	185 (454)

<sup>a</sup> Data from Mills (1987, 1988, 1989, 1990, 1991, 1992).

<sup>b</sup> Catches in parenthesis.

addition, the median CPUE for other species captured was estimated. Growth of recaptured Arctic char was determined.

## METHODS

To distribute sampling effort, Harding Lake was divided into quadrants and three limnological zones (Figure 1 and Table 2). The littoral zone was near-shore in water less than 10 m deep. The benthic zone was within 2 m of the bottom at water depths ranging from 10 to 36 m. The benthic zone was subdivided into four depth categories to spread sampling effort (Table 2). The pelagic zone was the entire water column at depths of over 30 m.

Each quadrant of the littoral zone was fished for eight 24-hour periods with fyke traps. The fyke traps had a 25 m center lead and 7.5 m wings. Each quadrant of each of the four depth categories within the benthic zone was fished for two 24-hour periods with a 40 m x 2 m, variable mesh, monofilament, sinking gill-net. Each quadrant of the pelagic zone was fished for two 24-hour periods with six vertical gill-nets. Each net was 3 m x 30 m, monofilament or multi-filament, and had a different mesh size which ranged from 12.7 mm to 63.5 mm (bar measure). All sampling took place from August 25 to September 4, 1992. All net locations in each quadrant were randomly chosen within each limnological zone. Sample design in 1992 was similar to that of test netting conducted during 1989, 1990, and 1991 (Viavant and Clark 1991a; Viavant 1992b). All captured fish were measured from tip-of-snout to fork-of-tail (FL) to the nearest millimeter and examined for finclips and Floy tags.

In addition to catches during this study, other sources of data (Appendix A) included incidental captures during spring assessment of the northern pike *Esox lucius*, population (Skaugstad and Burkholder 1992), tag returns from anglers, data gathered during a winter creel survey at Harding Lake (Merritt et al. 1990), and data taken during experimental hook and line fishing at Harding Lake (Viavant and Clark 1991b). The stocking history of Harding Lake since 1988 is provided in Appendix B.

### Relative Abundance

Relative abundance was defined as the median catch per net or trap in a 24-hour period or CPUE. The 95% confidence interval for the median CPUE was calculated as:

$$P(X_k \leq \text{median} \leq X_m) \geq 1 - \alpha, \quad (1)$$

where:  $k = C_{\alpha(2), n+1}$ ;

$m = n - C_{\alpha(2), n}$ ; and,

$C_{\alpha(2), n}$  = the two-sided critical values of the binomial with  $p = 0.5$  at  $\alpha = 0.5$ , for a sample of size  $n$  (Zar 1984).

The median CPUE of a species in a zone was classified as abundant, moderately abundant, or sparse, based on the numerical criteria for each species as provided in Appendix C. These abundance criteria were arrived at by polling

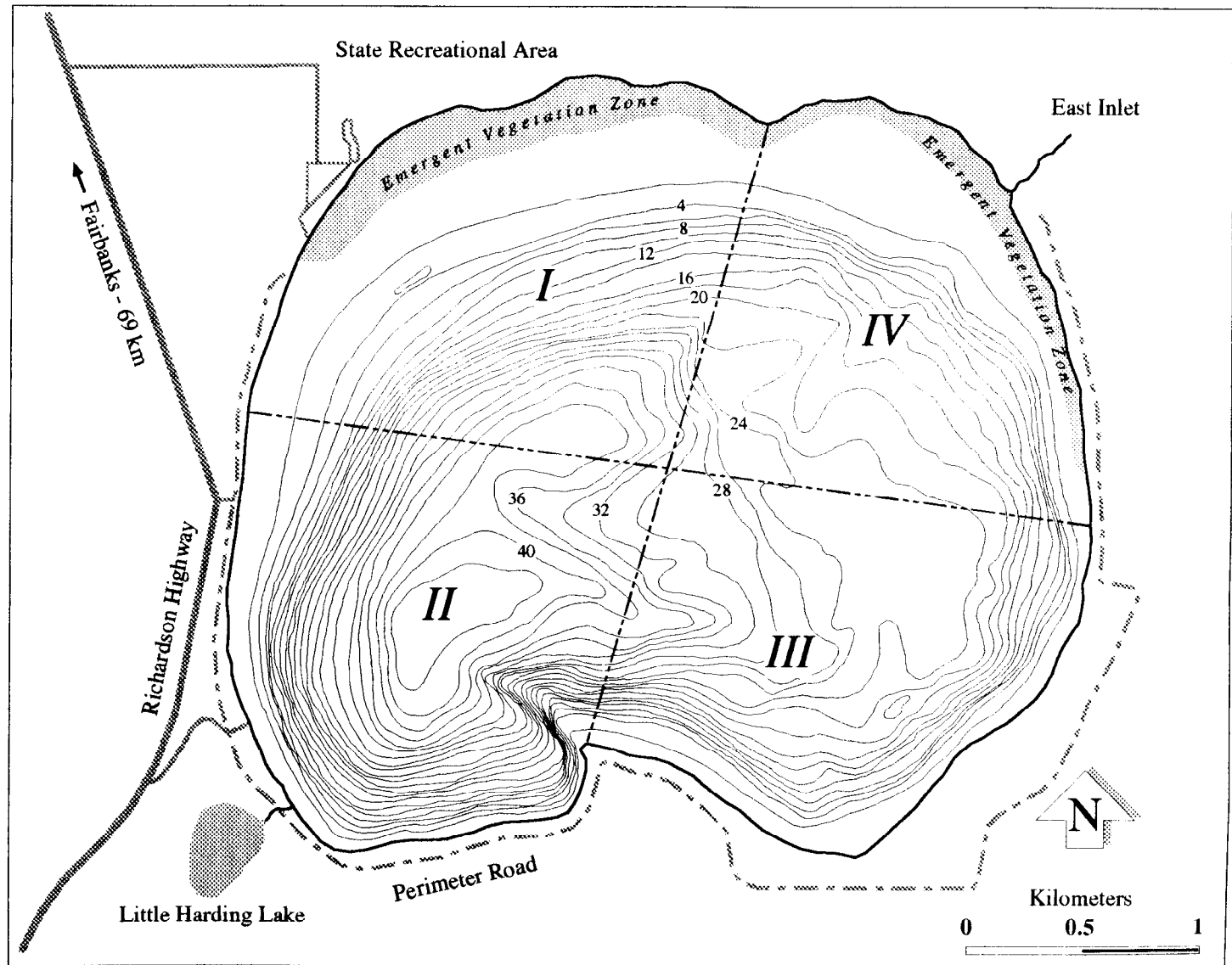


Figure 1. Map of Harding Lake, Alaska, showing quadrants used to disperse sampling effort.

Table 2. Zones, depths, and gear types used to sample fish in Harding Lake during August-September 1992.

Limnological Zone	Water Depth (m)	Gear Type	Number of Periods Fished <sup>a</sup>
Littoral	0 - <10	Fyke trap	32
Benthic	10 - <15	Sinking Gill-net	8
Benthic	15 - <21	Sinking Gill-net	8
Benthic	21 - <27	Sinking Gill-net	8
Benthic	27 - <37	Sinking Gill-net	8
Pelagic	>30	Vertical Gill-net	48

<sup>a</sup> A period is defined as 24 hours.

biologists regarding their opinions of what catch levels they would categorize as abundant, moderately abundant, or sparse for each species for a 24-hour period, and averaging the results (see Viavant and Clark 1991a). These abundance criteria were used only as a consistent basis for categorizing relative catch levels.

### Growth of Arctic Char

Prior to stocking, different cohorts of Arctic char were measured and marked with finclips and Floy anchor tags at Clear Hatchery. Because growth rates of Arctic char were shown to be dependent on the length of the fish at marking (Buklis 1978), growth data were grouped into 25 mm length categories based on fork-length at time of marking. Growth was subsequently estimated as follows:

$$G_{ij} = \frac{L(t_{rij}) - L(t_{mij})}{(t_{rij} - t_{mij})} \quad (2)$$

where:  $G_{ij}$  = growth in mm/day of the  $i^{th}$  fish in the  $j^{th}$  length category;  
 $L(t_{rij})$  = fork length at time of recapture of the  $i^{th}$  fish in the  $j^{th}$  length class;  
 $L(t_{mij})$  = fork length at time of marking of the  $i^{th}$  fish in the  $j^{th}$  length class;  
 $t_{mij}$  = time of marking in days, and;  
 $t_{rij}$  = time of recapture in days.

## RESULTS

### Catch Statistics and Relative Abundance

Catches of stocked species in 1992 were: 117 Arctic char, 0 rainbow trout, 0 Arctic grayling, and 8 kokanee (Table 3; Figure 2). Catches of naturally reproducing species were: 57 northern pike, 25 burbot, 23 lake trout, and 303 least cisco. Fishing effort totaled 32 24-hour periods with fyke nets in the littoral zone, 32 24-hour periods with gill nets in the benthic zone, and 48 24-hour periods with gill nets in the pelagic zone (Table 2). For stocked and resident species combined, 32 fish were captured in the littoral zone, 356 fish were captured in the benthic zone, and 155 fish were captured in the pelagic zone (Table 3, Figure 3).

#### Arctic Char:

Two Arctic char were captured in the littoral zone, 104 were caught in the benthic zone, and 11 were caught in the pelagic zone (Table 3). The median CPUE (and range) for: (1) the littoral zone was 0 (0 to 1); (2) the benthic zone was 2.5 (0 to 15); and, (3) the pelagic zone was 1.0 (0 to 9; Table 4). Relative abundance in the littoral, benthic, and pelagic zones were rated sparse, moderate, and sparse, respectively (Table 4).

Table 3. Total catch by species, size, and zone while test netting Harding Lake during August-September 1992.

		Number of Fish Caught						
		Zone <sup>a</sup>						
Species	Fork Length (mm)	Littoral	Benthic				Pelagic	Total
			10 m	15 m	21 m	27 m		
Arctic char	< 200	0	14	10	12	1	2	39
	≥ 200	2	6	29	10	22	9	78
Arctic grayling	< 200	0	0	0	0	0	0	0
	≥ 200	0	0	0	0	0	0	0
Lake trout	< 300	0	0	0	2	2	2	6
	≥ 300	0	1	5	7	0	4	17
Least cisco	All	0	4	21	93	60	125	303
Northern pike	< 300	2	0	0	1	0	0	3
	≥ 300	23	25	0	5	0	1	54
Rainbow trout	< 200	0	0	0	0	0	0	0
	≥ 200	0	0	0	0	0	0	0
Burbot	< 300	0	0	1	0	0	0	1
	≥ 300	0	1	4	4	3	12	24
Kokanee	< 200	0	0	0	0	0	0	0
	≥ 200	5	3	0	0	0	0	8
Zone Total		32	54	70	134	88	155	533
Number of net-nights		32	8	8	8	8	48	112

<sup>a</sup> The littoral zone consisted of near-shore water less than 10 m deep and fishing gear was fyke traps; the benthic zone consisted of water within 2 m of the bottom at depths listed and fishing gear was 40 m by 2 m, variable mesh, sinking gill-nets; and, the pelagic zone consisted of the entire water column at depths over 30 m and fishing gear was six vertical gill-nets composed of 3 m by 30 m panels, each of a different mesh size.

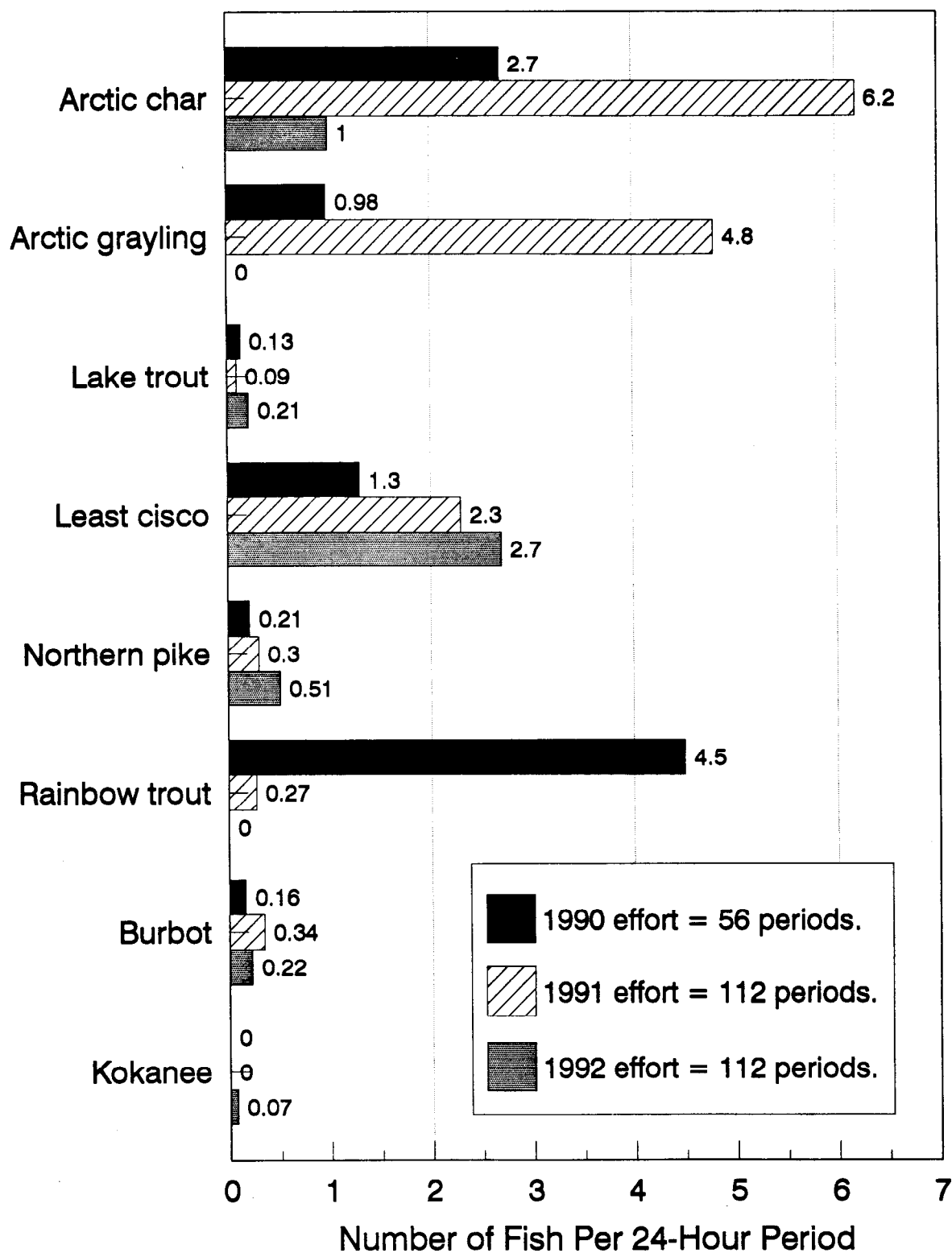


Figure 2. Total catches from all zones and gear types for each species caught while test netting Harding Lake during September 1990, September 1991, and August-September 1992.



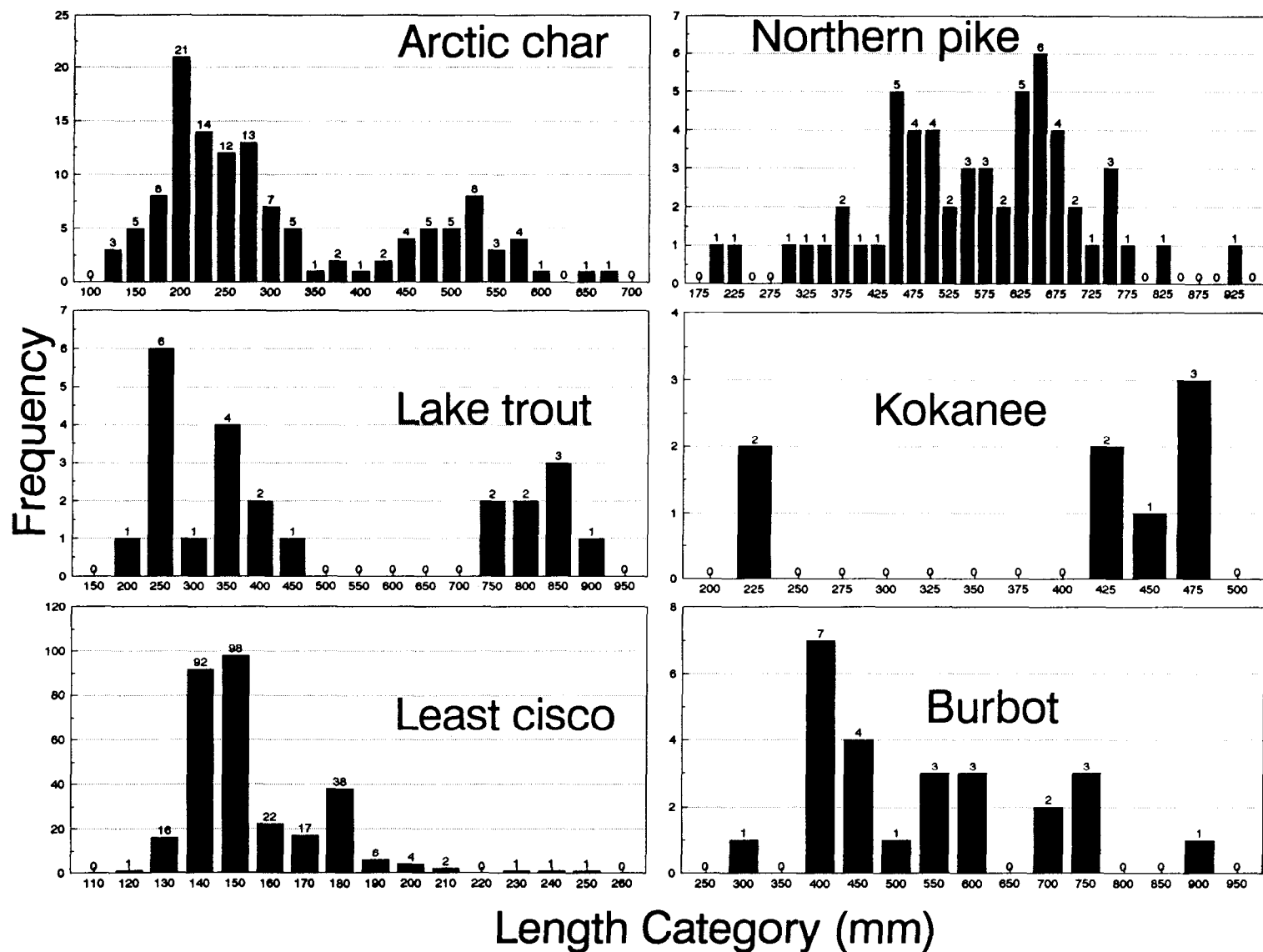


Figure 3. Length frequency distribution of Arctic char captured during test netting at Harding Lake, September 1992.

Table 4. Minimum, maximum, and median catches of fish per 24-hour period by zone and designated level of abundance, Harding Lake, August-September 1992.

Species	Zone <sup>a</sup>	Catch per period				Designated Abundance <sup>b</sup>
		Minimum	Maximum	Median	95% C.I.	
Arctic Char	Littoral	0	1	0	0 - 0	Sparse
	Benthic	0	15	2.5	1 - 4	Moderate
	Pelagic	0	9	1	0 - 9	Sparse
Arctic Grayling	Littoral	0	0	0	0 - 0	
	Benthic	0	0	0	0 - 0	
	Pelagic	0	0	0	0 - 0	
Lake Trout	Littoral	0	0	0	0 - 0	Sparse
	Benthic	0	4	0	0 - 1	Sparse
	Pelagic	0	2	0	0 - 2	Sparse
Least Cisco	Littoral	0	0	0	0 - 0	Sparse
	Benthic	0	29	0	0 - 8	Sparse
	Pelagic	6	33	13.5	6 - 33	Moderate
Northern Pike	Littoral	0	4	0	0 - 1	Sparse
	Benthic	0	10	0	0 - 0	Sparse
	Pelagic	0	1	0	0 - 1	Sparse
Rainbow Trout	Littoral	0	0	0	0 - 0	
	Benthic	0	0	0	0 - 0	
	Pelagic	0	0	0	0 - 0	
Burbot	Littoral	0	0	0	0 - 0	Sparse
	Benthic	0	3	0	0 - 0	Sparse
	Pelagic	0	4	1	0 - 4	Sparse
Kokanee	Littoral	0	2	0	0 - 0	Sparse
	Benthic	0	2	0	0 - 0	Sparse
	Pelagic	0	0	0	0 - 0	Sparse

<sup>a</sup> The littoral zone consisted of near-shore water less than 10 m deep and fishing gear was fyke traps; the benthic zone consisted of water within 2 m of the bottom at depths listed and fishing gear was 40 m by 2 m, variable mesh, sinking gill-nets; and, the pelagic zone consisted of the entire water column at depths over 30 m and fishing gear was six vertical gill-nets composed of 3 m by 30 m panels, each of a different mesh size.

<sup>b</sup> Criteria used to develop these abundance designations are in Appendix C.

During 1992, 14 marked fish from four of six marked cohorts of stocked Arctic char were captured during this and other studies in Harding Lake (Table 5, Appendix A). Three Arctic char were from the cohort stocked in November 1988, three were from February 1989, four were from May 1989, and four were from the cohort stocked in May 1991. No marked Arctic char were caught that were released from the net-pens in August 1990 or stocked from Clear Hatchery in March 1990.

#### Rainbow Trout:

No rainbow trout were captured during this study (Table 3). However, three rainbow trout were captured in gill nets in June 1992 during another study (Appendix A). Stocking cohort was not determined because these fish had no marks. Lengths of the two males were 462 and 468 mm and the length of the female was 427 mm. The three fish were sexually mature.

#### Arctic Grayling:

No Arctic grayling were captured during this study or any other study in 1992 (Table 3).

#### Northern Pike:

Twenty-five northern pike were captured in the littoral zone, 31 were captured in the benthic zone, and one was captured in the pelagic zone (Table 3). The median CPUE (and range) for: (1) the littoral zone was 0 (0 to 4); (2) the benthic zone was 0 (0 to 10); and, (3) the pelagic zone was 0 (0 to 1; Table 4). Relative abundance was rated sparse in all zones (Table 4).

#### Burbot:

No burbot were captured in the littoral zone, 13 were captured in the benthic zone, and 12 were captured in the pelagic zone (Table 3). The median CPUE (and range) for: (1) the benthic zone was 0 (0 to 3); and, (2) the pelagic zone was 1 (0 to 4; Table 4). Relative abundance was rated sparse in all zones (Table 4).

#### Lake Trout:

No lake trout were captured in the littoral zone, 17 were captured in the benthic zone, and six were captured in the pelagic zone (Table 3). The median CPUE (and range) for: (1) the benthic zone was 0 (0 to 4); and, (2) the pelagic zone was 0 (0 to 2; Table 4). Relative abundance was rated sparse in all zones (Table 4).

#### Least Cisco:

No least cisco were captured in the littoral zone, 178 were captured in the benthic zone, and 125 were captured in the pelagic zone (Table 3). Catches generally increased with depth in the benthic zone. The median CPUE (and range) for: (1) the benthic zone was 0 (0 to 29); and, (2) the pelagic zone

Table 5. Summary of recaptured fish from each marked cohort of Arctic char stocked into Harding Lake, 1988-1992.

	(Mean Length at Recapture)					
	11/1/88	02/8/89	5/22/89	3/22/90	8/23/90	5/30/91
Stocking Date:	11/1/88	02/8/89	5/22/89	3/22/90	8/23/90	5/30/91
Mean Length:	165 mm	210 mm	322 mm	339 mm	121 mm	369 mm
Number Stocked:	10,799	8,391	1,909	1,304	7,500/50,000	1,556
Type of Mark: <sup>a</sup>	AD Clip	RV Clip	Green Tag	Blue Tag	AD Clip	Blue Tag
Sampling Event						
1989						
Summer Netting	3	14 (253 mm)	16 (352 mm)	0	0	0
Hook & Line	2 (256 mm)	14 (266 mm)	44 (363 mm)	0	0	0
1990						
Winter Creel	0	8 (286 mm)	0	0	0	0
Summer Netting	3 (327 mm)	4 (350 mm)	10 (395 mm)	8 (382 mm)	2 (119 mm)	0
Hook & Line	0	1 (375 mm)	5 (392 mm)	2 (422 mm)	2 (146 mm)	0
1991						
Spring Netting	2 (360 mm)	1 (392 mm)	1 (452 mm)	0	0	1 (350 mm)
Summer Netting	7 (382 mm)	3 (402 mm)	3 (473 mm)	1 (374 mm)	0	27 (383 mm)
Hook & Line	0	0	7 (466 mm)	0	0	100
1992						
Spring Netting	1 (443 mm)	0	0	0	0	0
Summer Netting	2 (449 mm)	3 (514 mm)	4 (532 mm)	0	0	0
Hook & Line	0	0	0	0	0	4 (388 mm)

<sup>a</sup> AD = Adipose fin clip, RV = Right ventral fin clip.

was 13.5 (6 to 33; Table 4). Relative abundance was rated sparse in the littoral and benthic zones and moderate in the pelagic zone (Table 4).

#### Kokanee:

Five kokanee were captured in the littoral zone, three were captured in the benthic zone, and none were captured in the pelagic zone (Table 3). The median CPUE (and range) for: (1) the littoral zone was 0 (0 to 2); and, (2) the benthic zone was 0 (0 to 2; Table 4). Relative abundance was rated sparse in all zones (Table 4). Two size cohorts were captured.

#### Arctic Char Growth

Lengths of Arctic char captured at Harding Lake during August-September 1992 ranged from 116 mm to 675 mm. The length frequency distribution was bimodal; the modes were at 200 mm and 525 mm (Figure 3). About 72% of the captured fish were less than 400 mm.

Growth and growth rate were determined for six of the 14 recaptured Arctic char (Table 6). These six fish were marked with Floy tags and could be individually identified. The other eight fish were either marked with fin clips only or were marked with Floy tags but lengths were not recorded when captured. Four of the six fish were released into Harding Lake on March 9, 1989. Their lengths ranged from 300 to 325 mm. When captured in gill nets in August-September 1992 these fish had spent about 1,268 days in the lake. Their lengths when captured ranged from 505 to 546 mm. Growth ranged from 185 to 246 mm and the growth rate ranged from 0.15 to 0.19 mm per day. The other two fish were released on May 30, 1991, and their lengths were 320 and 375 mm. When captured by anglers in November 1992 these fish had spent 535 days in the lake. Their lengths when captured were 320 and 375 mm. Growth was 50 and 30 mm and the growth rates were 0.093 and 0.056 mm per day.

### DISCUSSION

Catches of each stocked and resident species were usually highest in one or two of the limnological zones. Arctic char, lake trout, burbot, and least cisco were captured in greatest numbers in the pelagic and benthic zones. Northern pike and kokanee were captured most often in the littoral and shallow benthic zones. Catch rates in the different limnological zones were probably an indicator of habitat preference of each species during August-September.

This is the first year that kokanee older than age 2 were captured. Kokanee were stocked in Harding Lake in 1988, 1989, and 1990 (Appendix B). Juvenile kokanee were captured in a tow-net in 1988, 1989, and 1990 (Clark and Doney 1988; Clark 1991). During the same period no kokanee were captured in gill nets or fyke nets (Viavant and Clark 1991a; Viavant 1992b). The kokanee is usually a pelagic, plankton feeder and is not usually found in shallow near-shore water except when spawning. In Canadian lakes, kokanee spawn in the fall and on gravel beds along shore. Generally, kokanee spawn at age 4. Kokanee stocked in 1988 were age 4 in 1992. The kokanee captured this year

Table 6. Growth and growth rate of Arctic char captured in Harding Lake, 1992.

Tag Number	Sex	Color	Date Stocked	Length (mm)	Date Captured	Length (mm)	Days	Growth (mm) Rate <sup>a</sup>	
3	F	Green	9-Mar-89	304	25-Aug-92	508	1,265	204	0.16
933	F	Green	9-Mar-89	325	28-Aug-92	545	1,268	220	0.17
88660	F	Green	9-Mar-89	320	4-Sep-92	505	1,275	185	0.15
89552	M	Green	9-Mar-89	300	25-Aug-92	546	1,265	246	0.19
69411	ND <sup>b</sup>	Blue	30-May-91	375	15-Nov-92	405	535	30	0.056
68312	ND <sup>b</sup>	Blue	30-May-91	320	15-Nov-92	370	535	50	0.093

<sup>a</sup> Growth rate = mm/day.

<sup>b</sup> Sex could not be determined.

were probably attempting to spawn. These fish did not produce eggs or milt when squeezed slightly but the larger kokanee had developed kypes.

The CPUE for Arctic char was less in 1992 compared to the CPUEs in 1990 and 1991. The larger CPUEs in 1990 and 1991 were probably due to stocking Arctic char within a few weeks of starting the study. These stockings were reflected in the size composition of the catch in 1991 (Viavant 1992b). Small Arctic char were stocked in the fall of 1990 and 1991 and small Arctic char comprised a large proportion of the catch in 1990 and 1991. In 1992, Arctic char were stocked after the study ended.

The number of Arctic char that were marked at Clear Hatchery and released as adults (> 200 mm) and then captured in gill nets has decreased each year. Compared to other stocking cohorts, few of these large fish were stocked and their decreasing contribution to catches in gill nets is probably the result of harvest by anglers. When stocking was initiated, large and small Arctic char were stocked but the small Arctic char were probably too small to contribute to the fishery. In contrast, the large Arctic char provided an immediate fishery.

The large Arctic char were produced at Clear Hatchery as brood stock for the stocking program. However, because survival rates exceeded what was predicted, more Arctic char were produced than were needed. Although additional funds were not required to produce these surplus fish, additional funds would be needed if these fish remained at the hatchery. By stocking these fish in Harding Lake the hatchery did not need additional funds, hatchery resources were free for other projects, and these fish created an immediate fishery.

The largest Arctic char captured in gill nets in 1992 were not marked and did not have deformed fins. These fish were probably stocked at less than 200 mm in 1988 or 1989. In hatcheries, fins are deformed through abrasion against the concrete surface of the raceways. At the time of stocking, the fins of older, larger fish are usually more abraded than those of younger, smaller fish. When Arctic char were initially stocked in Harding Lake, large fish allowed the fishery to begin immediately while the small fish would need one or two years to enter the fishery. As the small fish grew and entered the fishery, the stocking of large Arctic char would no longer be needed. The presence of these large unmarked Arctic char in gill nets indicates that the cohorts of fish that were stocked at less than 200 mm have grown and entered the fishery.

Arctic grayling and rainbow trout were captured in nets in 1990 and 1991 but no Arctic grayling were captured and only three rainbow trout were captured in 1992 during another study. Catches in 1990 and 1991 were probably influenced by stocking both species within a few weeks of starting the study. Size at the time of stocking for both species ranged from fingerlings to adults. No Arctic grayling were captured in 1991 or 1992 that were in Harding Lake for at least one year. No rainbow trout was captured that had been in Harding Lake more than two years. Only a few rainbow trout were captured that were in Harding Lake more than one year. These results indicate that survival of stocked Arctic grayling and rainbow trout was probably very low and size at

the time of stocking probably did not influence survival because survival was poor for all size cohorts. However, in the statewide harvest survey the estimated rainbow trout harvest was second only to the estimated northern pike harvest (Mills 1987-1992). However, catches of Arctic char, lake trout, and burbot in nets from 1990 to 1992 and catches during a hook and line study (Viavant and Clark 1991b) indicate that the relative abundance and harvest of rainbow trout is less than the other species. Anglers may have misidentified other species as rainbow trout.

Except for burbot, more resident species were captured in 1992 than in 1990 or 1991. In spring 1992, Skaugstad and Burkholder (1992) found that the abundance of northern pike in Harding Lake had increased and the increase was due mainly to more small fish in the population. The increased catch of northern pike in August-September 1992 may be the result of an increase of the number of northern pike in the lake.

The number of lake trout and least cisco captured during these studies in 1990-1992 suggest that the abundances of both species were increasing. However, the abundance of lake trout has never been estimated so there are no comparative data. From 1988-1990 the catches of least cisco in gill nets generally increased (Clark and Doxey 1988; Clark 1991). These two studies suggest that the abundance of least cisco was probably increasing during 1988-1992.

#### CONCLUSIONS

Arctic char that were stocked at less than 200 mm are now contributing to the fishery and stocking large Arctic char probably is not required to maintain the fishery.

No significant fisheries have developed for Arctic grayling or rainbow trout. Stockings of these species should cease until new evidence indicates either species will contribute to a fishery.

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## APPENDIX A

Appendix A. Number of Arctic char, rainbow trout, Arctic grayling, and kokanee caught, date and method of capture, and type of mark for fish captured at Harding Lake from 1989 through 1992.

Species	Date of Capture	Capture Method <sup>a</sup>	Number Caught	Type of Mark <sup>b</sup>	Size Cohort When Captured
Arctic char	6/89	TR	1	GT	
Arctic char	7/89	TN	97	N	
Arctic char	7/89	TN	14	RV	
Arctic char	7/89	TN	3	AD	
Arctic char	7/89	TN	16	GT	
Arctic char	11/89	TR	29	GT	
Arctic char	12/89	HL	141	N	
Arctic char	12/89	HL	14	RV	
Arctic char	12/89	HL	2	AD	
Arctic char	12/89	HL	1	GT/AD	
Arctic char	12/89	HL	3	GT/LV	
Arctic char	12/89	HL	5	GT/LP	
Arctic char	12/89	HL	1	GT/UC	
Arctic char	12/89	HL	4	GT/NC	
Arctic char	1-2/90	CC	23	N	
Arctic char	1-2/90	CC	8	RV	
Arctic char	6-9/90	TN	14	N	> 299 mm
Arctic char	6-9/90	TN	57	N	200 to 299 mm
Arctic char	6-9/90	TN	104	N	< 200 mm
Arctic char	6-9/90	TN	4	RV	
Arctic char	6-9/90	TN	3	AD	> 300 mm

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Appendix A. (Page 2 of 3).

Species	Date of Capture	Capture Method <sup>a</sup>	Number Caught	Type of Mark <sup>b</sup>	Size Cohort When Captured
Arctic char	6-9/90	TN	2	AD	< 200 mm
Arctic char	6-9/90	TN	3	GT/AD	
Arctic char	6-9/90	TN	3	GT/NC	
Arctic char	6-9/90	TN	1	GT/RV	
Arctic char	6-9/90	TN	2	GT/LV	
Arctic char	6-9/90	TN	1	GT/UC	
Arctic char	6-9/90	TN	8	BT/AD	
Arctic char	11/90	TR	4	GT	
Arctic char	12/90	HL	41	N	
Arctic char	12/90	HL	1	GT	
Arctic char	12/90	HL	1	RV	
Arctic char	12/90	HL	2	AD	< 200 mm
Arctic char	5/91	TN	2	N	
Arctic char	5/91	TN	1	RV	
Arctic char	5/91	TN	1	AD	
Arctic char	5/91	TN	1	GT/LP	
Arctic char	5/91	TN	1	BT/AD	
Arctic char	6-8/91	TR	100	BT	
Arctic char	6-8/91	TR	7	GT	
Arctic char	9/91	TN	25	N	≥ 300 mm
Arctic char	9/91	TN	634	N	< 300 mm
Arctic char	9/91	TN	3	RV	
Arctic char	9/91	TN	7	AD	≥ 300 mm

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Appendix A. (Page 3 of 3).

Species	Date of Capture	Capture Method <sup>a</sup>	Number Caught	Type of Mark <sup>b</sup>	Size Cohort When Captured
Arctic char	9/91	TN	3	GT/NC	
Arctic char	9/91	TN	28	BT/AD	
Arctic char	8-9/92	TN	39	N	< 200 mm
Arctic char	8-9/92	TN	68	N	< 200 mm
Arctic char	8-9/92	TN	3	AD	≥ 300 mm
Arctic char	8-9/92	TN	3	RV	≥ 300 mm
Arctic char	8-9/92	TN	4	GT/NC	≥ 300 mm
Arctic char	8-9/92	TR	4	BT/NC	≥ 300 mm
Rainbow trout	6-9/90	TN	64	BT/AD	
Rainbow trout	6-9/90	TN	177	N	≥ 150 mm
Rainbow trout	6-9/90	TN	12	N	< 150 mm
Rainbow trout	5/91	TN	9	N	
Rainbow trout	5/91	TN	5	AD	
Rainbow trout	5/91	TN	1	BT/AD	
Rainbow trout	6-8/91	TR	1	BT/AD	
Rainbow trout	9/91	TN	10	RV	
Rainbow trout	9/91	TN	20	N	
Rainbow trout	6/92	TN	3	N	> 200 mm
Arctic grayling	6-9/90	TN	55	N	< 150 mm
Arctic grayling	9/91	TN	1	GT	
Arctic grayling	9/91	TN	534	N	< 150 mm
Kokanee	8-9/92	TN	4	N	> 200 mm

<sup>a</sup> TN = test netting, HL = experimental hook and line sampling, TR = tag return (from anglers), CC = creel census sampling

<sup>b</sup> N = no mark, AD = adipose clip, RV = right ventral clip, LV = left ventral clip, LP = left pectoral clip, TC = top caudal clip, BT/\_\_\_ = blue tag with fin clip, GT/\_\_\_ = green tag with fin clip, GT/NC = green tag with no fin clip, GT = Green tag with unknown clip.

## APPENDIX B



Appendix B. Number of Arctic char, rainbow trout, Arctic grayling, and kokanee stocked, size at stocking, type of mark, and number marked, Harding Lake, 1988 - 1992.

Species	Stocking Date	Number Stocked	Size at Stocking (g)	Number Marked	Type of Mark <sup>a</sup>	Pen Reared
Arctic char	10/1/88	20,021	50.0	0		No
Arctic char	11/1/88	10,799	53.0	All	AD	No
Arctic char	2/8/89	8,391	122.0	All	RV	No
Arctic char	5/22/89	380	739.0	All	GT/AD	No
Arctic char	5/22/89	389	739.0	All	GT/LV	No
Arctic char	5/22/89	389	739.0	All	GT/LP	No
Arctic char	5/22/89	389	739.0	All	GT/TC	No
Arctic char	5/22/89	362	739.0	All	GT/NC	No
Arctic char	7/18/89	12,365	20.0	0		No
Arctic char	10/17/89	38,696	108.0	0		No
Arctic char	3/22/90	1,304	654.0	All	BT/AD	No
Arctic char	8/23/90	50,000	20.0	7,500	AD	Yes
Arctic char	8/30/90	32,733	35.5	0		No
Arctic char	9/14/90	18,561	54.0	0		No
Arctic char	5/30/91	1,556	761.0	ALL	BT/AD	No
Arctic char	7/19/91	106,050	11.0	0		No
Arctic char	8/30/91	171,376	37.7	0		No
Arctic char	6/16/92	60,603	9.0	0		No
Arctic char	6/17/92	60,603	9.0	0		No
Arctic char	6/18/92	60,000	9.0	0		No
Arctic char	6/19/92	8,928	9.0	0		No
Arctic char	6/23/92	11,190	9.0	0		No

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Appendix B. (Page 2 of 3).

Species	Stocking Date	Number Stocked	Size at Stocking (g)	Number Marked	Type of Mark <sup>a</sup>	Pen Reared
Arctic char	9/8/92	17,836	56.0	0		No
Arctic char	9/11/92	17,627	54.0	0		No
Arctic char	9/9/92	16,012	63.0	0		No
Arctic char	9/10/92	18,412	56.0	0		No
Arctic char	9/29/92	17,408	60.0	0		No
Arctic char	9/30/92	16,614	64.0	0		No
Arctic char	10/1/92	10,692	61.0	0		No
Rainbow trout	8/20/88	248,658	1.3	0		No
Rainbow trout	8/2/89	148,836	1.4	0		No
Rainbow trout	8/14/89	44,921	1.0	0		No
Rainbow trout	7/19/90	1,019	110.0	0		No
Rainbow trout	7/24/90	100,000	1.7	0		No
Rainbow trout	8/26/90	9,970	125.5	4,000	BT/AD	Yes
Rainbow trout	8/26/90	49,912	3.2	12,500	LV	Yes
Rainbow trout	8/28/90	99,907	6.9	25,000	LV	Yes
Rainbow trout	8/28/90	1,000	177.0	All	BT/AD	Yes
Rainbow trout	7/24/91	173,800	1.8	0		No
Rainbow trout	8/1/91	9,406	90.6	4,406	RV	Yes
Rainbow trout	6/19/92	19,517	100.0	0		No
Arctic grayling	6/17/88	1,169,806	0.02	0		No
Arctic grayling	6/7/90	54,200	0.02	0		No
Arctic grayling	8/28/90	2,400	3.9	0		Yes
Arctic grayling	8/29/90	29,972	5.2	0		Yes

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Appendix B. (Page 3 of 3).

Species	Stocking Date	Number Stocked	Size at Stocking (g)	Number Marked	Type of Mark <sup>a</sup>	Pen Reared
Arctic grayling	6/8/91	697,178	0.02	0		No
Arctic grayling	8/25/91	71	100.0	All	GT	Yes
Arctic grayling	8/27/91	186,800	3.9	0		Yes
Arctic grayling	8/28/91	150,200	2.6	0		Yes
Arctic grayling	9/20/91	43,397	5.3	0		No
Arctic grayling	6/19/92	400,000	0.02	0		No
Arctic grayling	6/24/92	204,263	0.02	0		No
Kokanee	5/23/88	503,000	0.16	0		No
Kokanee	5/22/89	515,000	0.16	0		No
Kokanee	6/7/90	505,305	0.16	0		No

<sup>a</sup> N = no mark, AD = adipose clip, RV = right ventral clip, LV = left ventral clip, LP = left pectoral clip, TC = top caudal clip, BT/AD = blue tag with adipose fin clip, GT/\_\_\_ = green tag with fin clip (AD, LV, LP, TC), GT/NC = green tag with no fin clip.

## APPENDIX C

Appendix C. Abundance criteria by species for Harding Lake used to categorize estimates of catch-per-24-hour-period.

Species	<u>Abundance Criteria for Average Catch Per Net-Night Data<sup>a</sup></u>		
	Sparse	Moderate	Abundant
Arctic char	0 to 1	2 to 6	more than 6
Arctic grayling	0 to 5	5 to 20	more than 20
Burbot	0 to 1	2 to 6	more than 6
Lake trout	0 to 1	2 to 6	more than 6
Least cisco	0 to 6	7 to 30	more than 30
Northern Pike	0 to 4	5 to 10	more than 10
Rainbow trout	0 to 5	6 to 20	more than 20

<sup>a</sup> These criteria represent the arithmetic average of values given by regional sport fish biologists for catches from a standard experimental gill-net.

